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**Evidence-based knowledge on the aesthetics and maintenance of
peri-implant soft tissues: Osteology Foundation Consensus Report Part
3-Aesthetics of peri-implant soft tissues**

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Abstract: OBJECTIVES Working Group 2 at the 2nd Consensus Meeting of the Osteology Foundation had a focus on the influence of vertical implant placement on papilla height at single implants adjacent to teeth and on the inter-implant mucosa fill at two adjacent implants in the anterior maxilla. MATERIALS AND METHODS Two systematic reviews were prepared in advance of the consensus meeting. Due to the heterogeneity among the studies with regard to study design, study population, method of assessment, meta-analyses were not possible. Consensus statements, clinical recommendations, and implications for future research were based on structured group discussions until consensus was reached among the entire expert group. RESULTS The systematic review about single-tooth implants included a total of 12 studies demonstrating that the vertical distance from the crestal bone level to the base of the interproximal contact point varied considerably from 2 mm up to 11 mm, and a partial or complete papilla fill was reached in 56.5% to 100% of the cases. For the systematic review regarding two adjacent implants, only four studies reported on horizontal inter-implant distances which ranged between 2.0 and 4.0 mm. More than half of the papilla presence was indicated in 21% to 88.5% of the cases. CONCLUSIONS It was concluded that for single-tooth implants, the papilla height between an implant and a tooth is predominantly dependent on the clinical attachment level of the tooth. In cases with two adjacent implants, it was concluded that it is not possible to define the optimal horizontal distance between two adjacent implants restored with fixed dental prosthesis.

DOI: <https://doi.org/10.1111/clr.13113>

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ZORA URL: <https://doi.org/10.5167/uzh-158027>

Journal Article

Published Version



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Originally published at:

Jung, Ronald E; Heitz-Mayfield, Lisa; Schwarz, Frank (2018). Evidence-based knowledge on the aesthetics and maintenance of peri-implant soft tissues: Osteology Foundation Consensus Report Part 3-Aesthetics of peri-implant soft tissues. *Clinical Oral Implants Research*, 29 Suppl:14-17.

DOI: <https://doi.org/10.1111/clr.13113>

Evidence-based knowledge on the aesthetics and maintenance of peri-implant soft tissues: Osteology Foundation Consensus Report Part 3—Aesthetics of peri-implant soft tissues

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Funding information

This Consensus Meeting was supported by a grant of the Osteology Foundation, Lucerne, Switzerland

Abstract

Objectives: Working Group 2 at the 2nd Consensus Meeting of the Osteology Foundation had a focus on the influence of vertical implant placement on papilla height at single implants adjacent to teeth and on the inter-implant mucosa fill at two adjacent implants in the anterior maxilla.

Materials and methods: Two systematic reviews were prepared in advance of the consensus meeting. Due to the heterogeneity among the studies with regard to study design, study population, method of assessment, meta-analyses were not possible. Consensus statements, clinical recommendations, and implications for future research were based on structured group discussions until consensus was reached among the entire expert group.

Results: The systematic review about single-tooth implants included a total of 12 studies demonstrating that the vertical distance from the crestal bone level to the base of the interproximal contact point varied considerably from 2 mm up to 11 mm, and a partial or complete papilla fill was reached in 56.5% to 100% of the cases. For the systematic review regarding two adjacent implants, only four studies reported on horizontal inter-implant distances which ranged between 2.0 and 4.0 mm. More than half of the papilla presence was indicated in 21% to 88.5% of the cases.

Conclusions: It was concluded that for single-tooth implants, the papilla height between an implant and a tooth is predominantly dependent on the clinical attachment level of the tooth. In cases with two adjacent implants, it was concluded that it is not possible to define the optimal horizontal distance between two adjacent implants restored with fixed dental prosthesis.

KEYWORDS

adjacent implants, aesthetics, bone crest, dental implants, horizontal distance, implants, maintenance, mucosa, papilla, peri-implant, vertical distance

1 | PREAMBLE

The dimensions of the soft tissues between a tooth and an implant (papilla) or between two adjacent implants (inter-implant mucosa) are influenced by the soft tissue health. Therefore, the evaluation of the scientific evidence of possible factors influencing the papilla/inter-implant mucosa must only be carried out in healthy soft tissues.

It was not within the main scope of these reviews to identify factors that may influence papilla height/inter-implant mucosa fill such as surgical and restorative protocols: staged vs. simultaneous implant placement, flapless placement, incision and flap design, soft and hard tissue augmentation procedures, submerged vs. transmucosal healing.

2 | INTRODUCTION

The aesthetic outcome of implant-supported reconstructions is strongly influenced by the natural appearance of the peri-implant soft tissue. Different aesthetic evaluation scores have been suggested to objectively evaluate the peri-implant soft tissue outcomes (Belser et al., 2009; Furhauser et al., 2005; Jemt, 1997). One of the parameters assessed is the height of the papilla between a single-tooth implant and the adjacent teeth or the peri-implant soft tissue fill between two adjacent implants.

To better predict the aesthetic outcome of implant-supported reconstructions, it would be beneficial to identify the ideal vertical distances of the papilla height in single-tooth implants and to identify the horizontal distance between two adjacent implants to achieve inter-implant mucosa fill.

However, there is currently no systematic review addressing the influence of the vertical distance between the bone crest and the interproximal contact point on the papilla height in single-tooth implant placement in the aesthetic zone. In addition, there are no evidence-based recommendations as to what should be considered the ideal horizontal inter-implant distance in order to ensure an optimal inter-implant mucosa fill and to achieve an ideal aesthetic treatment outcome.

Therefore, the aim of the present consensus report was to critically evaluate the scientific evidence regarding the influence of horizontal/vertical implant tissue dimensions on papilla height in single-tooth implants and on the inter-implant mucosa fill of two adjacent implants in the anterior maxilla.

3 | WORKSHOP DISCUSSION AND CONSENSUS

The present part 3 of the Osteology Foundation Consensus Report was based on the following reviews:

1. The influence of the vertical distance between the bone crest and the interproximal contact point on the papilla height—a

systematic review. Mario Rocuzzo, Andrea Rocuzzo, Ausra Ramanauskaite 2017.

2. The influence of the horizontal distance between the interproximal contact point and the bone crest on the inter-implant mucosa fill—a systematic review. Ausra Ramanauskaite, Andrea Rocuzzo, Frank Schwarz 2017.

At the beginning of the meeting, the authors presented the reviews in detail (i.e., methodology, results, and conclusions) to the participants. Subsequently, the participants were separated into two working groups (Group 1: Maintenance of peri-implant soft tissues; Group 2: Aesthetics of peri-implant soft tissues). Discussions and the formulation of consensus statements within groups were each directed by one chairperson and one secretary. The statements, elaborated by the members of the working groups, were presented and discussed in plenary sessions and revised according to the suggestions made by the audience. Finally, consensus statements, clinical recommendations, and implications for future research were approved.

4 | THE INFLUENCE OF THE VERTICAL DISTANCE BETWEEN THE BONE CREST AND THE INTERPROXIMAL CONTACT POINT ON THE PAPILLA HEIGHT—A SYSTEMATIC REVIEW

Mario Rocuzzo, Andrea Rocuzzo, Ausra Ramanauskaite

4.1 | Focused question

The following question was developed according to the population, intervention, comparison, and outcome (PICO) study design: “Does the vertical distance from the base of the interproximal contact point to the crestal bone level, at single implants adjacent to teeth, affect the interproximal papilla height?”

4.2 | Consensus statements

- Periodontal health is a prerequisite for evaluation of the influencing factors on the papilla height
- The papilla height between an implant and a tooth is predominantly dependent on the clinical attachment level of the tooth
- The papilla volume and the filling of the interproximal embrasure are also influenced by other factors and they are as follows:

1. tooth and anatomic-related factors (dimension of the tooth gap, bone morphology, tooth anatomy and position, mucosal thickness)
2. implant-related factors (configuration of the collar, implant abutment connection, implant-tooth distance, oral-facial implant position)

3. surgical-related factors (staged vs simultaneous, augmentation procedures, submerged vs. transmucosal healing)
 4. restoration-related factors (contact point/area, abutment design, crown contour)
- Based on four studies, with a high risk of bias, there is limited evidence that the vertical distance from crestal bone level to the base of the interproximal contact point, at a single implant, influences the interproximal papilla height. The greater the distance from the bone crest to the contact point, the higher the risk for incomplete papilla fill.
 - Based on the available evidence, it is not possible to identify a threshold distance that will predict complete papilla fill.
 - Finally, there is very limited evidence (two studies) that the timing of crown placement (i.e., immediately following implant placement or after soft tissue healing) has no influence on papilla fill.

4.3 | Clinical recommendations

1. To reduce the risk of aesthetic complications, a comprehensive periodontal examination including interproximal probing should be performed before implant placement to assess the clinical attachment level at the adjacent teeth.
2. The clinician should make every possible effort to prevent interproximal crestal bone loss and clinical attachment loss to achieve the best possible aesthetic outcomes.
3. Prior to surgery, the clinician should identify anatomic risk factors and consider appropriate prosthetic solutions to optimize papilla fill.
4. Prior to the initiation of treatment, the patient should be informed about the risk factors for incomplete papilla fill as well as the planned treatment procedures.

4.4 | Implications for future research

Further investigations should consider the following:

1. standardization of study design and assessment parameters including PROMs regarding papilla height and fill.
2. prospective long-term studies to verify whether immediate or delayed provisional restorations render better long-term aesthetic results (papilla fill).
3. development of surgical procedures to improve bone and/or papilla augmentation for single implants adjacent to periodontally compromised teeth.

5 | A SYSTEMATIC REVIEW ON THE INFLUENCE OF THE HORIZONTAL DISTANCE BETWEEN TWO ADJACENT IMPLANTS INSERTED IN THE ANTERIOR MAXILLA ON THE INTER-IMPLANT MUCOSA FILL

Ausra Ramanauskaite, Andrea Rocuzzo, Frank Schwarz

5.1 | Focused question

The following question was developed according to the population, intervention, comparison, and outcome (PICO) study design: "Does the horizontal distance between two adjacent implants inserted in the anterior maxilla affect the inter-implant mucosa fill?"

5.2 | Consensus statements

- Based on four studies with a moderate risk of bias, it was not possible to define a value for the optimal horizontal distance between two adjacent implants restored with implant-supported crowns
- Based on three studies with a moderate to high risk of bias, there is a tendency for incomplete inter-implant mucosa fill when the inter-implant distance is < 3 mm
- The inter-implant mucosa volume and the filling of the inter-implant embrasure are also influenced by other factors and they are as follows:

1. anatomic-related factors (dimension of the edentulous space, mucosal thickness, bone volume on the facial aspect)
2. implant-related factors (configuration of the collar, implant abutment connection, oral-facial and apico-coronal implant position, implant angulation)
3. surgical-related factors (surgical protocols, e.g., staged vs. simultaneous, augmentation procedures and submerged vs. transmucosal healing)
4. restoration-related factors (contact point/area, abutment design, crown contour).

5.3 | Clinical recommendations

In the anterior maxilla (premolar to premolar), the recommendations are as follows:

- Two adjacent implants should be placed with an inter-implant bone distance of 3–4 mm to optimize inter-implant mucosa fill.
- If the inter-implant bone distance is <3 mm, a single implant with a crown and a cantilever should be considered.
- No clinical recommendation can be given for the timing of implant placement on the inter-implant mucosa fill.

5.4 | Implications for future research

Further investigations should consider the following:

- a standardization of study designs and assessment parameters including PROMs regarding inter-implant mucosa fill.
- prospective long-term follow-ups to verify whether time of implant placement (immediate or delayed) or time of implant provisionalization (immediate or delayed) renders better aesthetic results (inter-implant mucosa fill).

- a development of surgical procedures to improve bone and/or inter-implant mucosal augmentation for multiple adjacent implants in the anterior maxilla with vertical bone deficiencies.

ACKNOWLEDGEMENTS

This consensus meeting was supported by a grant of the Osteology Foundation, Lucerne, Switzerland. Ronald E. Jung and Frank Schwarz are members of the Osteology Foundation Board and have received grants, personal fees, and other support from the Osteology Foundation.

CONFLICT OF INTEREST

The authors and members of the working groups declare that they have no conflict of interests related to this consensus report

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How to cite this article: Jung RE, Heitz-Mayfield L, Schwarz F. Evidence-based knowledge on the aesthetics and maintenance of peri-implant soft tissues: Osteology Foundation Consensus Report. *Clin Oral Impl Res*. 2018;29(Suppl. 15):14–17. <https://doi.org/10.1111/clr.13113>